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Research Article

Applications of Artificial Intelligence in Mechanical Engineering

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Abstract

Artificial intelligence (AI) technology, as one of the most sophisticated science and technology in today's world, is increasingly being used to production and life, particularly in the manufacturing business. it demonstrates how artificial intelligence technology is used in mechanical manufacturing, namely in defect detection, quality inspection, enhancing workplace safety, and other areas. Artificial intelligence technology is becoming increasingly important in people's lives as it becomes more widely used in people's daily lives, such as the widespread use of smart dishwashers and smart sweepers, which are the products of the fusion of artificial intelligence and the mechanical manufacturing industry. Indeed, artificial intelligence technology has been widely utilized in the mechanical manufacturing business, which not only ensures production precision, but also enhances job productivity and workplace safety. The rise of artificial intelligence has caused significant changes in the manufacturing industry as a whole. Without exception, the manufacturing industry must rely on AI technology to accomplish automation and intelligent development, as well as to improve productivity. Using artificial intelligence to categorize mechanical components, we may propose parts from a based solely on an image or CAD model. To find a necessary component in a machines we must currently browse through a catalogue and be able to discern which part you want based on the available possibilities and your understanding of the catalogue. There are serial numbers to memorize since a single digit or character change might indicate a different sort of part. The algorithm will choose which sections are the best and will significantly facilitate our search.

Keywords: Artificial Intelligence (AI), Machine Learning, Deep Learning, Manufacturing Technologies, Mechanical Engineering.

Makine Mühendisliğinde Yapay Zeka Uygulamaları

Öz

Günümüz dünyasının en gelişmiş bilim ve teknolojilerinden biri olan yapay zeka (AI) teknolojisi, üretimde ve yaşamda, özellikle imalat alanında giderek daha fazla kullanılmaktadır. Yapay zeka teknolojisinin imalat, mekanik kusur tespiti, kalite denetimi, iş yeri güvenliğini artırma ve diğer alanlarda kullanılmaktadır. Yapay zeka teknolojisi, yapay zeka ile mekanik imalat sanayinin füzyonunun ürünleri olan akıllı bulaşık makineleri ve akıllı süpürücülerin yaygınlaşması gibi, insanların günlük yaşamlarında daha yaygın bir şekilde kullanılmaya başlanmasıyla birlikte, insanların yaşamlarında giderek daha fazla önem kazanmaktadır. Gerçekten de yapay zeka teknolojisi, yalnızca üretim hassasiyetini sağlamakla kalmayan, aynı zamanda iş üretkenliğini ve iş yeri güvenliğini de artıran mekanik imalat işlemlerinde yaygın olarak kullanılmaktadır. Yapay zekanın yükselişi, imalat endüstrisinde bir bütün olarak önemli değişikliklere neden olmuştur. İstisnasız imalat endüstrisi, otomasyonu ve akıllı geliştirmeyi gerçekleştirmenin yanı sıra üretkenliği artırmak için yapay zeka teknolojisine güvenmelidir. Mekanik bileşenleri kategorize etmek için yapay zekayı kullanarak, yalnızca bir görüntüye veya CAD modeline dayalı olarak parçalar üretebiliriz. Bir makinede gerekli bir bileşeni bulmak için şu anda bir kataloğa göz atmamız ve mevcut olanaklara ve katalog anlayışınıza bağlı olarak hangi parçayı istediğinizi ayırt edebilmemiz gerekir. Tek bir rakam veya karakter değişikliği farklı türde bir parçayı gösterebileceğinden, ezberlenmesi gereken seri numaraları vardır. Algoritma hangi bölümlerin en iyi olduğunu seçecek ve aramamızı önemli ölçüde kolaylaştıracaktır.

Anahtar Kelimeler: Yapay Zeka, Makine Öğrenimi, Derin Öğrenme, Üretim Teknolojileri, Makine Mühendisliği.
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VISIT…

1. Introduction

Artificial intelligence is now the most represented technology in this discipline as a subfield of computer science. By imitating, extending, and increasing human intellect, it seeks to comprehend the nature of intelligence and create equivalent Intelligent robots. Virtual reality technology, emulation technology, and speech recognition technology are just a few of the many ways that artificial intelligence, in general, examines. Artificial intelligence (AI) technology, as one of the most advanced science and technology in the current society, has been applied more and more widely to production and life, and especially in manufacture industry.

There are several ways artificial intelligence (AI) may be used in mechanical engineering. The design and optimization of mechanical systems and parts, such as engines, gears, and bearings, may be automated using AI, for instance. The performance of mechanical systems may also be simulated and analyzed using AI in order to forecast behavior, spot future issues, and suggest changes. AI may also be used to track and manage mechanical systems in real-time, improving their dependability and efficiency. Overall, applying AI to mechanical engineering may assist to increase the effectiveness, dependability, and performance of mechanical systems as well as promote the creation of novel and cutting-edge technologies.

Different ideas have arisen as a result of the advancement of technology, and terms like robots, machines, and learning machines are now often used. Even if these ideas appear to be at odds with one another, they are connected. Humans and even animals possess an inherent intelligence that is now starting to be incorporated into computers and robots. Numerous corporate sectors now employ artificial intelligence extensively, and new applications are being discovered all the time. Artificial intelligence is not being developed to eliminate jobs for people. Its primary goal is to expand already-existing company sectors and perhaps start new business lines. Artificial intelligence conjures up the idea of a human-like electromechanical robot taking the place of people. It is clear that computers will never be able to transmit human creativity, passion, and character in the same way that they can with modern technology. Additionally, it appears that computers may be able to control devices like robots that mimic some physical human actions. They may also be able to serve as the brains of systems that replicate human thought processes in domains like data analysis and medical diagnosis.

In smart applications, the terms artificial intelligence, machine learning, and deep learning are frequently used interchangeably. However, there are distinctions between them. A part of machine learning is called deep learning. All machine learning applications are considered to be examples of artificial intelligence since machine learning is a subset of artificial intelligence that may operate intelligent applications.

A broad field, artificial intelligence encompasses sophisticated and complicated operations. This is why there are several ideas, techniques, and technologies in his field of study. Cognitive computing is the term for intelligent systems that communicate with one another and with humans. These systems learn via interactions with people and the environment around them rather than from explicit programming.

One may argue that the development of artificial intelligence has significantly altered the manufacturing sector as a whole. Without exception, the manufacture sector must rely on AI technology in order to achieve automation, intelligent development, and to better satisfy its demands in the new era of the 4.0 industrial revolution.

2. Material and Method

Learning in human intelligence is comparable to learning in artificial intelligence and learning made possible by neurons. In order to develop digital neurons and artificial neural networks, computer programs were used to replicate how neurons in human intellect function. Artificial intelligence now has the ability to learn by digesting many data and information inputs and to build abilities like issue solving in accordance with the analyses that arise from these data thanks to these newly generated digital neurons and artificial neural networks. Artificial intelligence-enabled machines and robots are not confined to carrying out the duties that are given to them. They are simultaneously capable of making a variety of choices depending on the knowledge they have received from the material accumulating in their memories (Andrew Ng, 2022).

The manner that their algorithms learn is where deep learning and machine learning diverge from one another. Larger datasets may be used since deep learning considerably automates the feature extraction phase of the process and eliminates some of the need for manual human interaction (Khan M.A., 2014).

Although a labeled dataset is not always required for this sort of learning, deep machine learning can benefit from supervised learning, commonly known as labeled datasets. Unstructured data (such text and photos) may be incorporated by deep machine learning, which can also automatically recognize feature sets that separate various data types. We can grow machine learning more interestingly since it doesn't require human interaction to interpret data, unlike machine learning. The acceleration of advancement in fields like computer vision, natural language processing, and speech recognition is mostly attributed to deep learning and neural networks.

Artificial neural networks (ANNs), often known as neural networks, are made up of node layers with an input layer, one or more hidden layers, and an output layer. Each artificial neuron or node is linked to others and has a threshold and weight that go with it. Any top individual node whose output exceeds the predetermined threshold becomes active and transmits information to the following network tier. If not, no data is sent to the following network layer (Valarmathi G., et al., 2021).

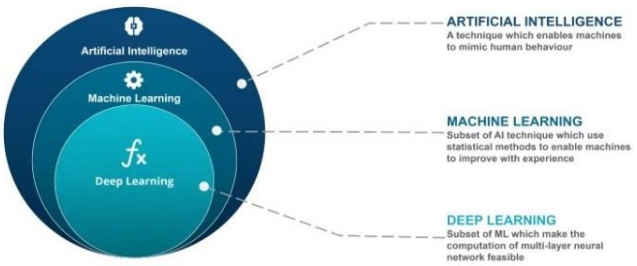


Figure 1. Artificial Intelligence and its subsets.

The depth of layers in a neural network is all that is meant by the "deep" aspect of deep learning. A deep learning algorithm or deep neural network may be thought of as a neural network with more than three layers inputs and outputs. A simple neural network is one that has just two or three layers (Yang J.R., 2019).

Machine learning is the process of developing software that can learn from experience without explicit programming. For example, a program may learn how to interpret a handwritten message from an image or diagnose breast cancer from medical data without being expressly programmed to do so. This also includes programs that can play computer games, stack things, walk, play chess, play go, etc.

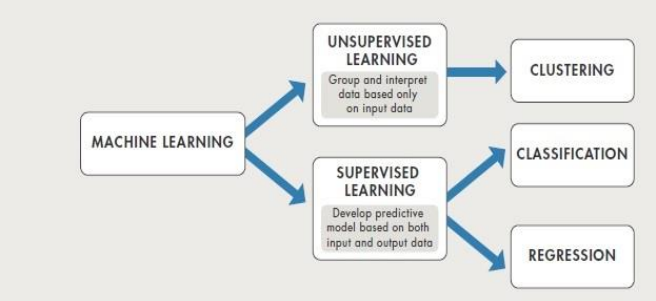


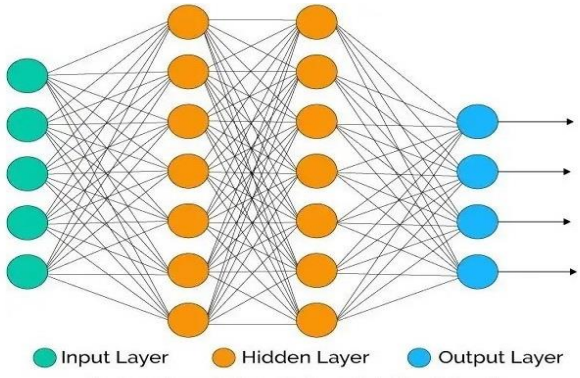
Figure 2. Maching Learning Techniques.

3. Results and Discussion

In addition to providing solutions for various aspects of daily life, artificial intelligence is also utilized for tasks including forecasting, categorization, and clustering. Artificial intelligence investigates the modeling of the human brain and living systems that do their tasks flawlessly. Artificial intelligence technologies often refer to methodologies like expert systems, genetic algorithms, fuzzy logic, artificial neural networks, and machine learning. In addition to these tactics, living things are looked at in order to mimic nature, and comparable clever strategies are recommended. Artificial intelligence optimization strategies employ algorithms like ant colonies, particle swarms, and artificial bees.. What is meant by artificial intelligence in general terms; It is the transfer of human intelligence to machines (computers and software) by modeling physiological and neurological structures such as nervous system, gene structure and natural events (Atalay M., 2017).

Humans have been gradually displaced by machines, and the mechanical manufacturing business has made extensive use of micro-electric technology, computer science, and automation technology. The production of mechanical goods was evolving toward integration. The age of intelligence has arrived in mechanical industry. The fourth industrial revolution involves integrating the internet, big data, cloud computing, the internet of things, and artificial intelligence into the mechanical manufacturing industry as of the beginning of the twenty-first century (Elmas Ç., 2011) (Shirkhorshidi, A. S., et al., 2014).

In summary, artificial intelligence; “Thinking like a human, behaving like a human, thinking rationally and acting rationally (Balaban, M.E., et al., 2015) are computer systems that have the behaviors considered as intelligent by living things, and machine



.**Figure 3.** A basic neural network (Valarmathi G., et al., 2021).

learning is accepted as the last stage of artificial intelligence in this sense (Wu A.H., et al., 2019).

3.1. Applications of AI in Engineering

CAD uses artificial intelligence (AI) that typically operates on knowledge-based systems. In CAD, design artifacts, rules, and issues are archived for subsequent use by CAD designers. AI and CAD are combined using model-based reasoning (MBR). Knowledge-based systems are widely used in recent software releases. Generative design is a key area where AI is being used. A generative design tool produces potential designs after receiving design criteria as input. In its 2018 release, SolidWorks offers a topology optimization capability by utilizing several generative design-based algorithms (Bao C.W., et al., 2019).

A project called Dreamcatcher was started by Autodesk and it enables generative design. Engineers can choose a design offered by software using this tool rather than designing through the hit-and-trail approach after observing appropriate trade-offs for any features (Charniak, E., et al., 1985).

There has been a lot of interest in computational fluid dynamics among mathematicians, physicists, and engineers. Direct Numerical Simulation has a much harder time solving fluid mechanics problems because of the turbulence and chaos that are involved (DNS). Reynold's-Averaged Navier-Stokes equation (RANS) and Large Eddy Simulation (LES) are two models that are accessible for approximating flow behavior, and AI has also made its way among them. Academics are becoming more interested in artificial neural networks (ANN) because they have the ability to approximate flows with less processing power, time, and dimensional reduction of issues. Additionally, they exhibit high agreement with conventional CFD models. The difficult part is teaching ANN via several example scenarios. Additionally, using neural networks prevents you from understanding the flow process (Liv J.N., 2018).

In order for engineers to analyze, optimize, and guarantee the quality of the product, the fourth industrial revolution will connect every piece of equipment used in a manufacturing facility and consumer goods. Engineers that can interpret sensor data in-depth will be needed to manage such technological data. Working on software that can manage data given by sensors in components of power plants, industrial facilities, or consumer items will demand mechanical engineers with AI expertise.

Power plant optimization is only one use of data science. Failures can be predicted using data from Supervisory Control and Data Acquisition (SCADA), preventing any loss of life or money (Jason B., 2018).

Python is the most used programming language for machine learning (ML). R as well as Python are both viable tools for data analysis. The majority of mechanical engineers will employ AI and ML as a component of a tool, such as CAD/CAM or FEA software, or to assist data analysis and decision-making.

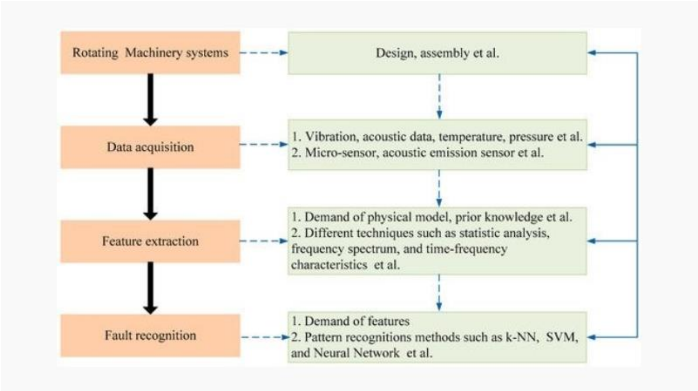


Figure 4. Mechanical Design and AI (Conor McDonald, 2017).

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Using artificial intelligence in engineering for manufacturing, analysis, and design Artificial intelligence and machine learning for robotics, smart materials and material modeling, intelligent damage detection and control optimal mechanical system design Autonomous driving, automated parking, and renewable energy in automobile engineering.

4. Conclusions and Recommendations

As it allows us to glean a great deal of knowledge from unstructured data, the branch of research known as deep learning (artificial intelligence) offers a vast array of potential applications. It is fundamentally just data analysis. Data is available everywhere in the internet era, and if we can effectively extract it, we can do a lot.

There are several potential uses for this area in the realm of mechanical engineering as well. Even though they didn't specialize in computer sciences, it would be beneficial for all engineers interested in data analytics to learn about data science, machine learning, and consider its prospects because practically all studies in deep learning require a domain expert. We will genuinely succeed in our areas if we have domain knowledge and data analysis skills.

The theoretical strategy could be more appropriate if you have a solid understanding of mathematics. Before beginning to study AI, it is important to be familiar with the following areas in mathematics: All the fundamental math, including matrices, vectors, and functions Statistics, probability, and linear algebra Calculus should decide on a technique based on your prior experience (math/coding) and your future research goals.

Designing intelligent tools, gadgets, and systems to improve society's standard of living is the exclusive emphasis of the emerging engineering profession known as artificial intelligence. AI now encompasses a wide spectrum of computer power and massive datasets thanks to the incorporation of machine learning techniques. Designing, managing, and evaluating AI features properly requires an engineering background. Artificial intelligence offers a complete framework and tools for creating machine learning algorithms in a dynamic environment throughout the enterprise-to-edge spectrum. The three pillars of artificial intelligence are human-centric AI, scalable AI, and robust AI.

Machine learning techniques that enable Artificial Intelligence models to operate similarly to human minds and bodies must be developed, programmed, and trained by AI engineers. They don't need to write expert code in a number of programming languages, but they do need to find vast volumes of real-time organized and unstructured data from multiple sources. AI Engineering supports the infrastructure of smart goods and services as well as the development of artificial intelligence. To achieve understandable AI, they must be able to fully communicate the functioning of AI models to collaborators, teams, and stakeholders.

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